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Engineering Process Management and Improvement at Lockheed Martin ATM

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Overview

- **Current process management at LMATM**
  - **The LMATM Business Process System**
  - **Process tailoring and program baselines**
  - **Process improvement.**
- **Lessons learned**
  - **Problems and issues.**
- **Work in progress**
  - **Improved process structures.**
- **Future directions**
  - **Web process navigation.**

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Process at LMATM

- **LMATM is CMM Software level 4, CMM Systems Engineering level 3, and ISO 9000 compliant.**
- **Transition to ISO 9001:2000 and CMMI level 3 is in progress.**
- **The LMATM Business Process System (BPS) is our repository of processes, encompassing all LMATM activities, and covering administration, finance, business development etc., as well as engineering and operations.**
- **LMATM has a serious commitment to process compliance and process improvement at all levels of management.**

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Motivation

- **Explicit, clear processes support staff by helping them know what they are supposed to be doing.**
- **Processes are our "corporate memory" for progressively improving practices.**
- **Auditable conformance of program work to ISO/CMM compliant processes is required to maintain our ISO/ CMM certifications/assessments - a business need.**
- **Standard processes allow easier re-deployment of staff to new programs as business circumstances change, and help support operation of "virtual teams" spanning multiple locations.**

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LMATM Business Process System

- **BPS is a structured collection of ISO/CMM compliant processes. The collection:**
  - **Includes ~200 standard processes (many in multiple versions), plus tailored program processes**
  - **Is subject to continuous audit, maintenance and improvement**
  - **Applies to all geographic locations within LMATM**
  - **Is accessible to all program personnel on the LMATM intranet via a web interface.**
  - **Is maintained under full configuration management.**
- **Processes are owned and managed/improved by functional areas (e.g., Engineering, QA, Operations…)**
  - **Business Improvement Council processes define common management/control/improvement policies**
  - **Functional area ownership supports buy-in and commitment, and avoids a central SEPG bottleneck.**

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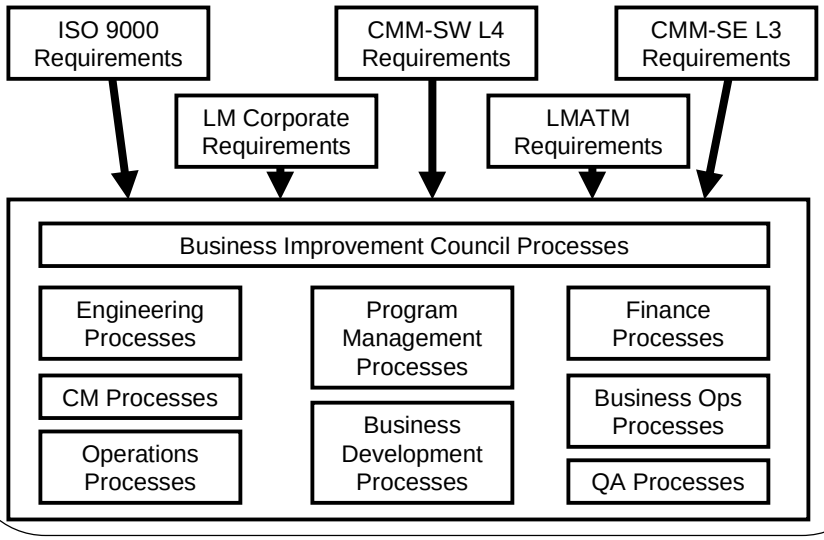
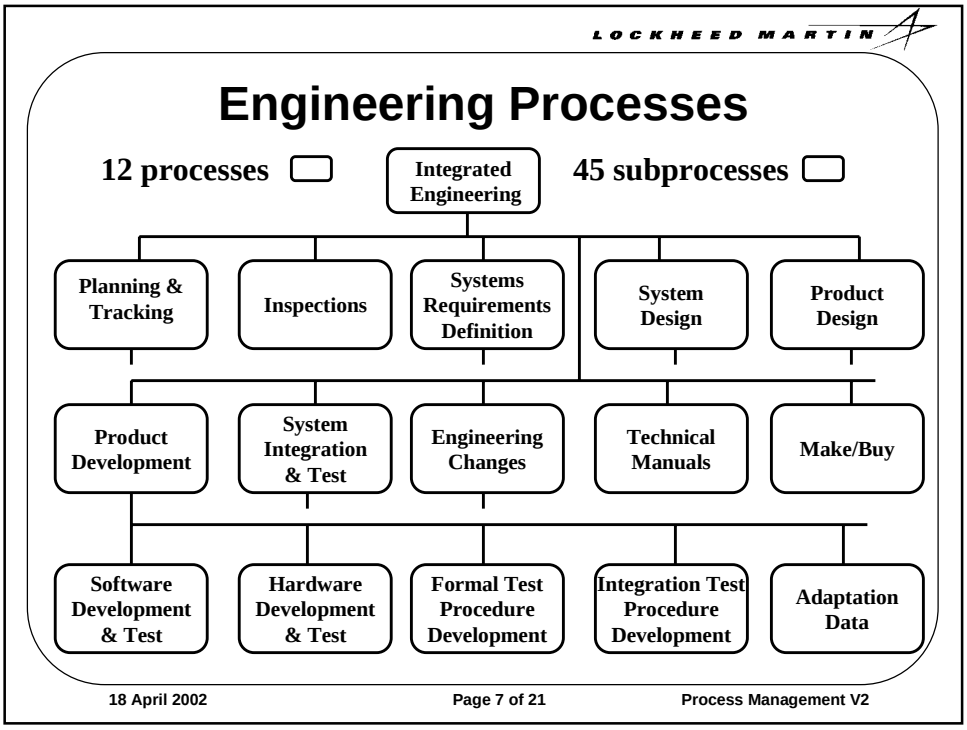
LMATM Business Process System

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Engineering Processes
12 processes
Integrated Engineering
45 subprocesses
Planning & Tracking
Inspections
Systems Requirements Definition
System Design
Product Design
Product Development
System Integration & Test
Engineering Changes
Technical Manuals
Make/Buy
Software Development & Test
Hardware Development & Test
Formal Test Procedure Development
Integration Test Procedure Development
Adaptation Data
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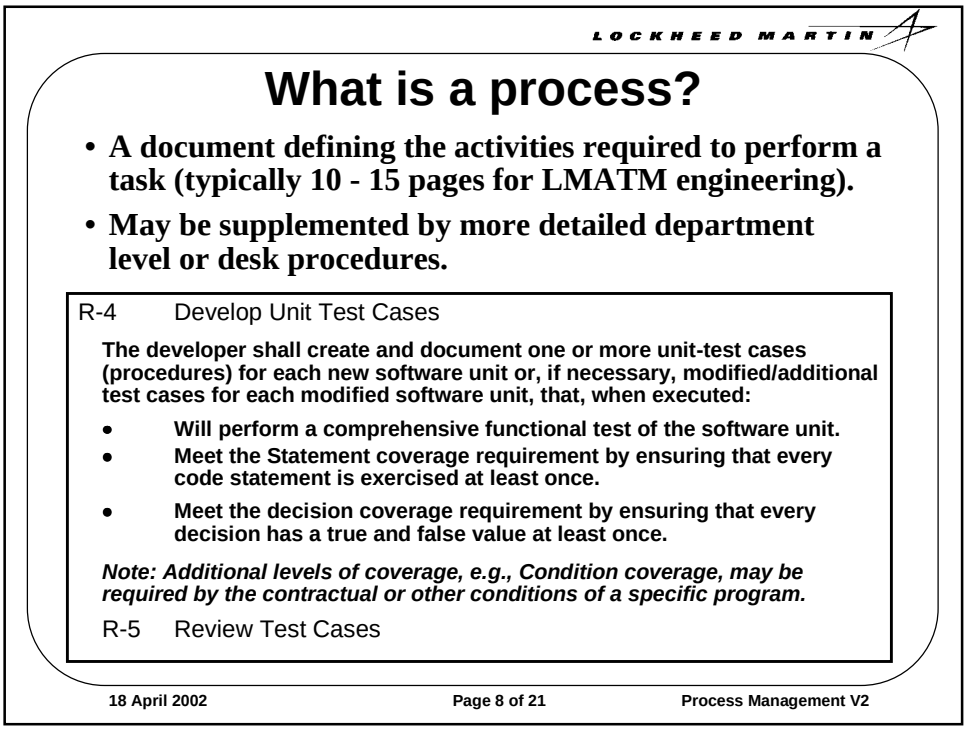
Process Management V2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What is a process?
• A document defining the activities required to perform a task (typically 10 - 15 pages for LMATM engineering).
• May be supplemented by more detailed department level or desk procedures.
R-4 Develop Unit Test Cases
The developer shall create and document one or more unit-test cases (procedures) for each new software unit or, if necessary, modified/additional test cases for each modified software unit, that, when executed:
• Will perform a comprehensive functional test of the software unit.
• Meet the Statement coverage requirement by ensuring that every code statement is exercised at least once.
• Meet the decision coverage requirement by ensuring that every decision has a true and false value at least once.
Note: Additional levels of coverage, e.g., Condition coverage, may be required by the contractual or other conditions of a specific program.
R-5 Review Test Cases
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Process Management V2

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Tailoring Program Processes

- **A tailored process adds program-specific details to a standard process, or supplements the standard process with additional program-specific requirements.**
- **A tailored process maintains compliance with the BPS requirements (LMATM, ISO, SEI CMM) for the corresponding standard process - if it does not, a waiver is required.**
- **Typically, a tailored process supplements a standard process, and the two must be read in conjunction.**

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Program Process Baselines

- **A program process baseline is a collection of processes covering all program activities.**
- **The engineering process baseline for a new program includes:**
  - **applicable standard processes from the current standard engineering process baseline**
  - **tailored processes to meet program specific needs**
  - **(occasionally) customer mandated and/or controlled processes.**
- **All program performance (work conducted as part of the program) must be in accord with the process baseline, unless a deviation or a waiver is approved.**

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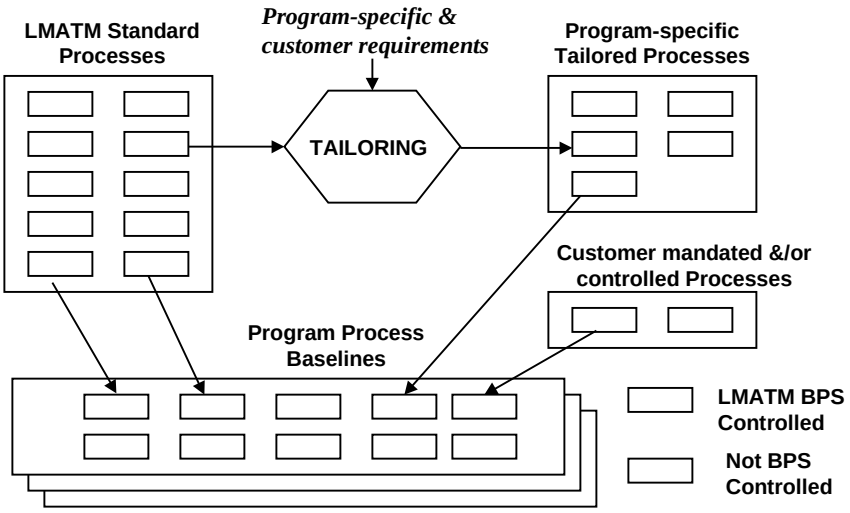
Program Process Baselines



Maintains traceability of LM, ISO, CMM requirements to program processes

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Process Change and Improvement

- **Processes and their performance are subject to continuous review by users, managers and technical leads, program process leads, and independent QA, any of whom may initiate a process change.**
- **Process change is managed by functional area Process Control Boards, following their defined processes.**
- **Completed, approved standard engineering process changes are released to the standard process baseline, and adopted into program process baselines following a program-specific schedule (updates every ~3 month).**
- **Changes to tailored program processes are adopted into the program baseline immediately on completion and approval.**

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Lessons Learned (1)

- **Significant process improvement is rare: most process change is maintenance:**
  - **The majority of process changes are corrective maintenance - consistency maintenance, fixing minor problems identified through use on specific programs, etc. - or minor optimizations**
  - **Repetitive maintenance introduces complexity and inconsistency, and makes improvement harder.**
- **Mechanisms are needed to drive systematic improvement efforts:**
  - **Systematic improvement of a mature process system is difficult and expensive; incremental approaches are essential.**
  - **"External" drivers, e.g., CMMI transition, corporate "lean process" cost takeout initiatives, can be exploited to initiate improvement efforts.**
  - **Process change metrics may help to identify priority candidates for process improvements.**

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Lessons Learned (2)

- **Process systems are systems too:**
  - **Managing multiple versions and variants of many processes and configurations (process baselines) built from them, while maintaining traceability to source standards, is hard**
  - **Full-scale systems engineering and configuration management approaches are needed.**
- **The needs of user support and standards compliance need to be balanced:**
  - **Process users want to know what they are supposed to do next.**
  - **Process engineers and QA (sometimes) believe that the purpose of a process is to generate objective evidence of ISO compliance.**

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Lessons Learned (3)

- **Picking the right level of process detail is critical:**
  - **Processes should specify "what", not "how", but need to be sufficiently specific to provide useful guidance**
  - **Over detailed processes are hard to use and maintain, and may force unnecessary tailoring or waivers.**
- **Process structure and format matter:**
  - **Process structure and format strongly influence how easy it is to use, maintain, and improve processes**
  - **Purely textual processes, which mix requirements with guidance, and define process flow implicitly, make use, maintenance, and improvement harder than necessary.**

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Work in Progress - Revised Process Structure

- **Objectives:**
  - **Improve the clarity and readability of processes.**
  - **Support process users by clearly and concisely defining what they need to do.**
  - **Simplify process modification and tailoring.**
  - **Facilitate process improvement.**
  - **Simplify the maintenance of traceability between processes and ISO, CMM, etc. requirements.**
- **Approach:**
  - **Define the order of process steps with a flowchart (extended data flow notation).**
  - **Provide a concise definition of mandatory requirements for each step shown on the flowchart in the form of "shalls".**
  - **Separate non-mandatory guidance material into an independent section, cross-referenced to the mandatory step requirements.**

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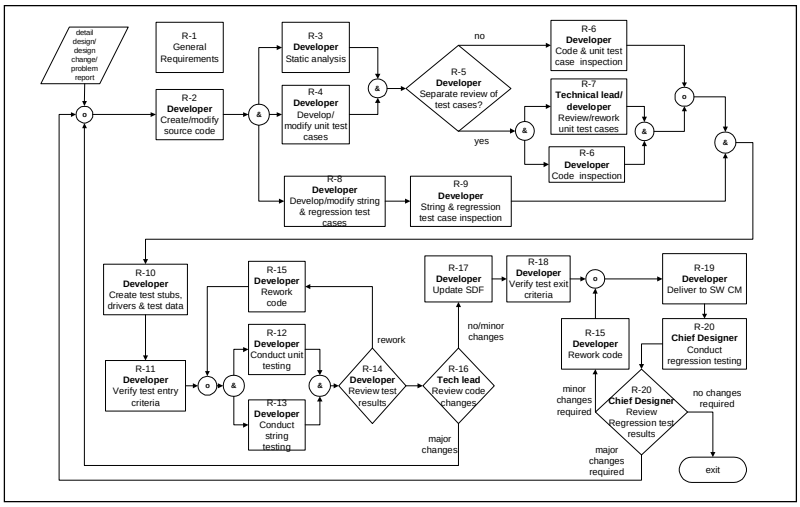
Example Process Flow

Software Code and Test



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Example Process Step Requirement

R-4 Develop Unit Test Cases

For guidance, see G-4

The developer shall create and document one or more unit-test cases (procedures) for each new software unit consistent with the unit test plan (see ATM-E35-S003, *Software Design*); or, if necessary, modified/additional test cases for each modified software unit, that, when executed:

- **Will perform a comprehensive functional test of the software unit.**
- **Meet the Statement coverage requirement by ensuring that every code statement is exercised at least once.**
- **Meet the decision coverage requirement by ensuring that every decision has a true and false value at least once.**

Note: Additional levels of coverage, e.g., Condition coverage, may be required for some or all of the code by the contractual or other conditions of a specific program.

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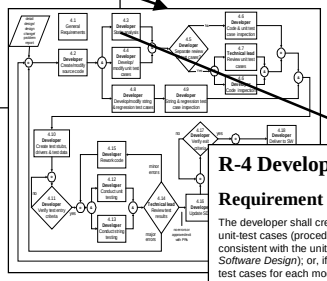
Future: Web Process Navigation

Hardware Development & Test
Software Code and Test
Adaptation Data



R-4 Develop Unit Test Cases

Requirement

The developer shall create and document one or more unit-test cases (procedures) for each new software unit consistent with the unit test plan (see ATM-E35-S003, *Software Design*); or, if necessary, modified/additional test cases for each modified software….

Guidance

The number of tests required depends on the number of input parameters, the number of decision points within the code, and special conditions such as state-dependent processing. Typical conditions covered by unit tests are: ….

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Web Navigation Approach

- **Maintain all versions and variants of process components (flowcharts, process step requirements, guidance sections, etc.) in a CM database.**
  - **A particular version of a given process is defined by an appropriate configuration of process components**
  - **A tailored process is a configuration incorporating program-specific variants of some components.**
- **Use active server pages to generate required views of processes (e.g., a navigable view, a printable view) from a database configuration.**

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Summary

- **LMATM has a mature ISO/CMM compliant process system, governing all LMATM program activities.**
- **Functional area process ownership facilitates process commitment; organizational management policies ensure overall integrity.**
- **We are exploiting lessons learned to drive incremental improvements in the process system.**
- **Future improvements will build on currently available technology to further improve process usability and maintainability.**